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Warning

CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 2, 2015

FINAL EXAMINATION	**DURATION**
SCH102 – Organic and Inorganic Chemistry	Reading Time: **10** minutes Writing Time: **180** minutes

INSTRUCTIONS TO CANDIDATES

The examination has 3 sections

Section A: Suggested Time: 60 min	Multiple Choice Questions: Answer all (40) questions Total: 40 marks (1 mark each)
Section B: Suggested Time: 60 min	Short Answer Questions(Inorganic Chemistry): Answer all (5) questions Total: 30 marks (6 marks each)
Section C:Suggested Time: 60 min	Short Answer Questions(Organic Chemistry): Answer all (5) questions Total: 30 marks (6 marks each)

Section A must be answered on the multiple choice answer sheet provided.

Section B and Sections C must be answered in **two separate answer booklets.**

EXAM CONDITIONS

This is a CLOSED BOOK examination

Any calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

Answer on the supplied examination material/s only

ADDITIONAL AUTHORISED MATERIALS	**EXAMINATION MATERIALS TO BE SUPPLIED**
No additional printed material is permitted	2 x 8 Page Book 1 x 4-Multiple Choice Answer Sheet Formula Sheet and Periodic table

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Section A
Multiple Choice Questions

This section should be answered on the **multiple choice sheet** provided. Please ensure that your name and student number is written on the **sheet** and placed in the completed answer Booklet.
1 mark for each question. **Total Marks for this section: 40**
Suggested Time allocation for Section A: **60 minutes**

Section B - Inorganic Chemistry
Short Answer Questions
Answer all (5) questions. Total Marks for This Section: 30 Marks

This section should be answered in the Answer Booklet provided.
Marks for each question are indicated. Suggested Time allocation for Section B: **60 minutes**

Question 1

(a) Balance the reaction by half reaction method by clearly showing the steps involved.

$$\mathbf{Cr_2O_7^{2-}(aq) + SO_3^{2-}(aq) \rightarrow Cr^{3+}(aq) + SO_4^{2-}(aq)}$$

[Marks: 3]

(b) Given the following two half-reactions:

$$\mathbf{Hg_2^{2+}(aq) + 2\,e^- \rightarrow 2\,Hg(\mathit{l})} \qquad \mathbf{\mathit{E}^\circ = +0.789\ V}$$

$$\mathbf{Al^{3+}(aq) + 3\,e^- \rightarrow Al(s)} \qquad \mathbf{\mathit{E}^\circ = -1.66\ V}$$

(i) Calculate the standard cell potential of the galvanic cell formed by above two redox couples.

(ii) Write the cell notation for the galvanic cell consisting of the above two redox couples.

[Marks:3]

Question 2

(a) Some batteries used in watches contains mercury(II) oxide. As current flows, the mercury oxide is reduced to mercury.

$$\mathbf{HgO(s) + H_2O(}\boldsymbol{l}\mathbf{) + 2\ e^- \rightarrow Hg(}\boldsymbol{l}\mathbf{) + 2\ OH^-(aq)}$$

If 2.0×10^{-5} amperes of current flows continuously for 365 days, what mass of Hg(*l*) is produced?

[Marks: 3]

(b) Consider an electrochemical cell at 25^o C, where $[Cr^{2+}] = 0.15$ M and $[Al^{3+}] = 0.0040$ M, based on the following reaction:

$$\mathbf{3\ Cr^{2+}(aq) + 2\ Al(s) \rightarrow 3\ Cr(s) + 2\ Al^{3+}(aq)}$$

The standard reduction potentials are as follows:

$$\mathbf{Cr^{2+}(aq) + 2\ e^- \rightarrow Cr(s)} \quad \boldsymbol{E}\mathbf{° = -0.91\ V}$$
$$\mathbf{Al^{3+}(aq) + 3\ e^- \rightarrow Al(s)} \quad \boldsymbol{E}\mathbf{° = -1.66\ V}$$

Calculate the cell potential at 25°C?

[Marks:3]

Question 3

(a) Not all 'Group 1 metals' react with nitrogen. Give an example each of a metal that reacts and a metal that does not react with nitrogen. Write a balanced equation for the metal that reacts with nitrogen.

[Marks:2]

(b) Metals react differently with dilute nitric acid and concentrated nitric acid.

Write two balanced chemical equations to show the reaction of **iron** with dilute and concentrated nitric acid.

[Marks:2]

(c) Give one form (name) of natural occurrence of the following metals:

(i) Mg

(ii) Ca

(iii) K

(iv) Al

[Marks: 2]

Question 4

(a) With the help of Lewis dot diagrams explain whether the following ligands can or cannot form linkage isomers?

(i) NH_3

(ii) NO_2

[Marks:2]

(b) Consider the coordination compound $Mg_2[Cr(CN)_6]$:

(i) Give the systematic name of the compound

(ii) Will the complex be a high-spin or low-spin complex?

(iii) If the three cyanide ligands are replaced by ammine ligands, what will be the charge on the resulting complex ion? Show your working.

[Marks:4]

Question 5

(a) Explain the terms ‘pyrometullargy’ and ‘hydrometallurgy’.

[Marks:2]

(b) Give the names and formula of 2 allotropic forms of oxygen.

[Marks:2]

(c) Noble gases are generally considered to be unreactive. However, compounds of certain noble gases can be produced. Give an equation which shows the production of a noble gas compound.

[Marks:1]

(d) Phosphorus is too reactive. Hence, pure phosphorous is stored under water. What happens when phosphorous comes in contact with oxygen gas? Explain with the help of an equation.

[Marks:1]

Section C - Organic Chemistry
Short Answer Questions
Answer all (5) questions. Total Marks for This Section: 30 Marks

This section should be answered in the Answer Booklet provided.
Show <u>all</u> formulas and working.
Marks for each question are indicated. Suggested Time allocation for Section C: **60 minutes**

Question 1

(a) Use an orbital energy level diagram to explain how electrons fill up orbitals of a nitrogen atom

[Marks: 1]

(b) Expand the explanation to show electron orbital hybridisation of a nitrogen atom as an amine, a imine and a nitrile

[Marks: 3]

(c) From the above, explain how VSPER theory predicts the shape of tri-methylamine and the cyanide anion

[Marks: 2]

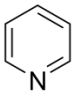
Question 2

(a) Using Weyland diagrams explain the mechanism and regioselectivity of the reaction of tert-butyl chloride with ethoxybenzene

[Marks: 3]

(b) Explain with Weyland diagrams the regioselectivity of the reaction with benzaldehyde

[Marks: 1]

(c) Explain using Hund's rule the reasons why pyridine,  , is more basic than pyrrole,  .

[Marks: 2]

Question 3

(a) Use Newman projections and rotational energy diagrams to identify the most stable confirmation of the 2-3 bond in (2S,3R)-2-chloro-3-methylpentane

[Marks: 3]

(b) Explain the mechanism and products and their stereochemistry for the reaction between the above compound and a strong base.

[Marks: 3]

Question 4

(a) Using R-2-chlorobutane as an example, compare and contrast SN1 and SN2 reactions.

[Marks: 3]

(b) Explain the starting materials, mechanism and products of one oxidation and one reduction of the carbonyl group

[Marks: 3]

Question 5

(a) Give a structure or structures consistent with each of the following sets of ^{13}C NMR data for compound $C_3H_6Cl_2$ (explain your answer).

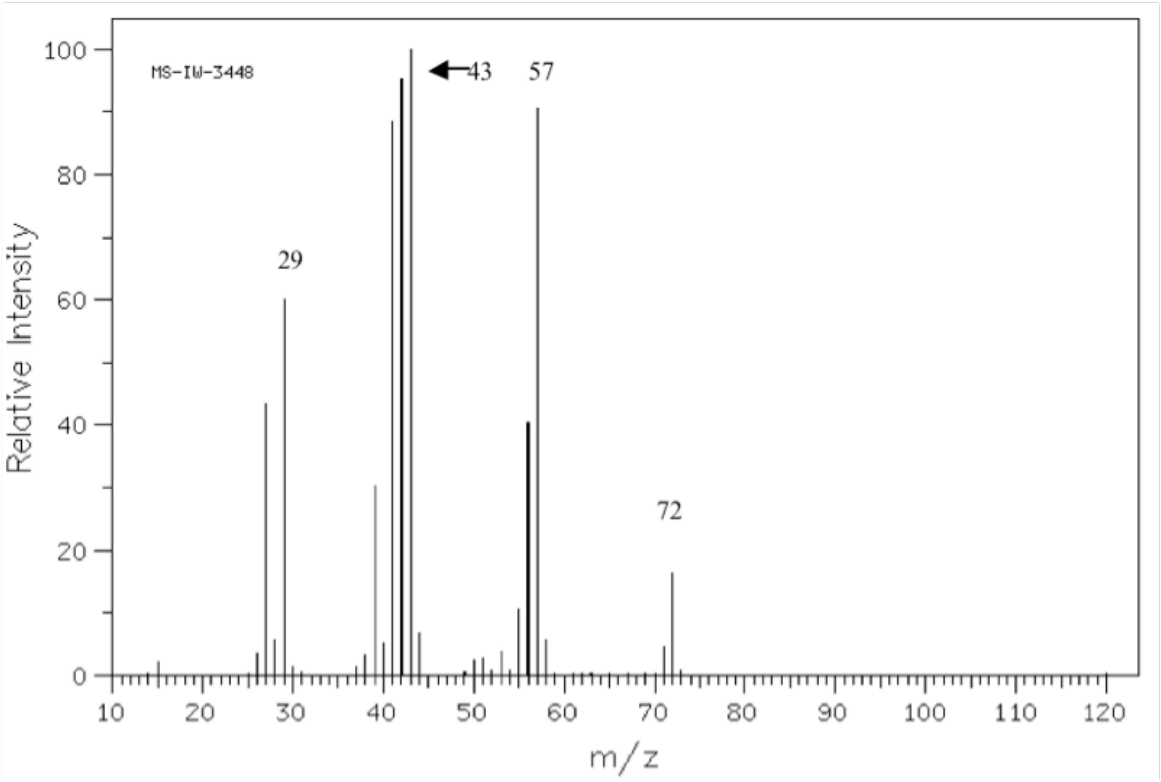
(i) quartet δ 22.4

(ii) triplet δ 49.5

(iii) doublet δ 55.8

[Marks: 3]

(b) In the spectrum below:



i) What peak represents M+?

ii) What peak represents the base peak?

iii) Propose structures for fragment ions at *m/z* = 57, 43 and 29

[Marks: 3]

FORMULA SHEET:

Some physical constants that might be useful:

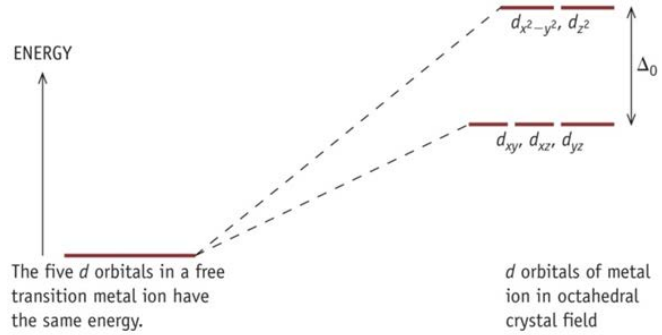
Avogadro's number, $N_A = 6.022 \times 10^{23}$
Universal gas constant, $R = 8.314$ J/K.mol = 8.314 volt.coulomb/(mol.K
1 cal = 4.184 J
Faraday's constant, F = 96500 coulomb/mol

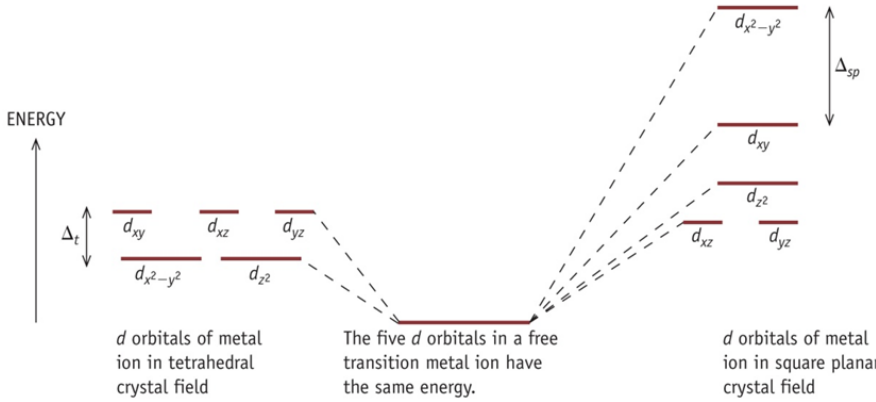
Some equations that might be useful

$$E_{cell} = E°_{cell} - \frac{RT}{nF}\ln Q \qquad Q = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

$$m_{deposited} = \frac{it}{96500}\left(\frac{MM}{n_e}\right)$$

$$pH = -log[H_3O^+]$$

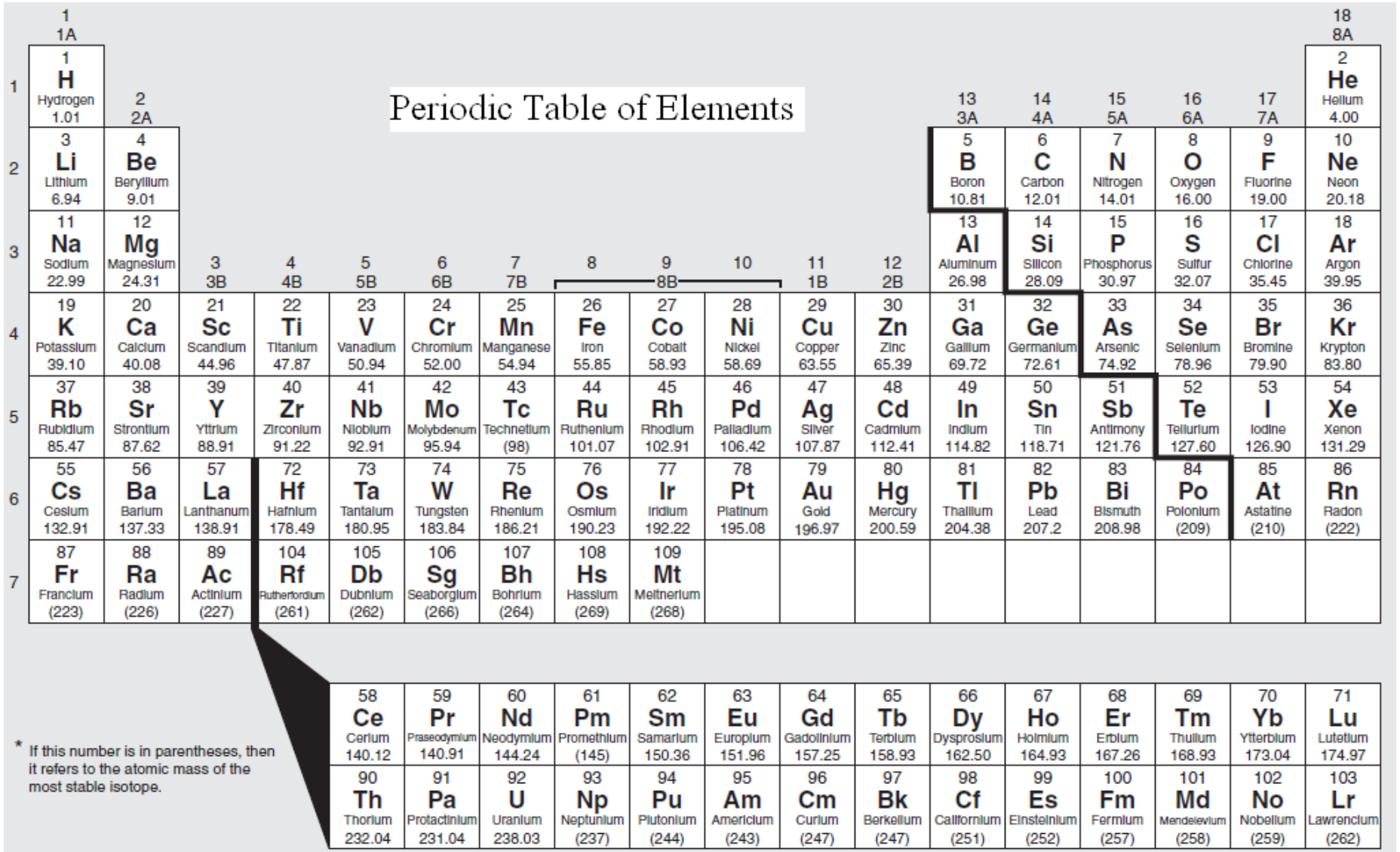




Ligands

$I^- < Br^- < SCN^- < Cl^- < F^- \leq OH^-$, $ONO^- < OH_2 < NCS^- < NCCH_3 < NH_3$, $py < NO_2^- < CN^-$, NO, CO

weak-field ligands *strong-field ligands*



FINAL EXAMINATION
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